

UNITED STATES OF AMERICA



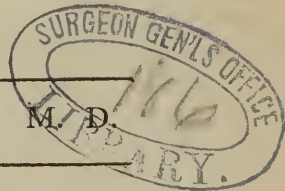
FOUNDED 1836

WASHINGTON, D.C.

A COMPLETE
T R E A T I S E
O N T H E
M I N E R A L W A T E R S
O F
V I R G I N I A :

CONTAINING
A DESCRIPTION OF THEIR SITUATION,
THEIR NATURAL HISTORY, THEIR
ANALYSIS, CONTENTS, AND THEIR
USE IN MEDICINE.

BY JOHN ROUELLE, M.D.



—when I those alpine mounts ascend
I sit me down a pensive hour to spend.

PHILADELPHIA:
PRINTED FOR THE AUTHOR, BY CHARLES CIST,
AND TO BE SOLD BY THOMAS DOBSON.
M,DCC,XCII.

District of PENNSYLVANIA, to wit :



BE it remembered, that on the eighteenth Day of January, in the sixteenth Year of the Independence of the United States of America, John Rouelle, of the said District, hath deposited in this Office, the Title of a Book, the Right whereof he claims as Author, in the Words following, to wit :

“ A complete Treatise on the mineral Waters of
“ Virginia: containing a Description of their Situ-
“ ation, their natural History, their Analysis, Contents,
“ and their Use in Medicine. By John Rouelle, M. D.
“ ———when I those alpine Mounts ascend
“ I sit me down a pensive Hour to spend.”

In Conformity to the Act of the Congress of the United States, intituled, “ An Act for the Encouragement of Learning, by securing the Copies of Maps, Charts and Books, to the Authors and Proprietors of such Copies, during the Times therein mentioned.”

SAMUEL CALDWELL,
Clerk of the District of Pennsylvania.

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P R E F A C E.

*T*HE treatise on mineral waters, which I now offer to the public, however concise it may be thought, will be of some utility, not only to invalids, but also to mankind in general, on account of the variety of observations it contains, which may be employed in many other researches.

Water, whether it be considered in general as an element, according to the old opinion, or as a compound fluid, as it has been proved by recent authors, offers itself as a subject very deserving the attention of philosophers. In this treatise I speak of it in combination with different heterogeneous substances, which do not enter into its constitution as a fluid, but are foreign to it.

Every one knows the great importance of common water in the different functions of the animal economy; this subject is much more neglected at this time than it was by the Greeks. That nation, in general very good observers of nature, never founded towns, houses, &c. without having previously well examined the natural history of the place, the kind of waters, &c. as much as the state of science in their time permitted. These circumstances are plainly described by Hippocrates, de aere et locis. The

Romans

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Romans, great imitators of the Greeks, were very cautious upon the same subject, as it appears by the accounts of their architecture preserved by Vitruvius, so that among the precepts of that art, after the ground is explored, it is recommended to attend particularly to the water, as a necessary point for the comfort of human life.

Men in their undertakings of this nature too often neglect these objects, and it is only when large cities are built, that the water becomes a subject of thought and reflection. So it has happened with the several towns in Europe, where all these conveniences have been neglected, &c.

It is nevertheless very easy to make a good analysis of the waters intended to supply any city, whether they are taken from a river, run, springs or wells, and each of these waters often has different qualities in different places.

These differences, sometimes, depend on the various substances they contain, sometimes, on the difference of their proportions. There are some of them which are improved by exposure to the open air; some others require different precautions to retain their active principles for the advantage of the animal œconomy. We have a striking instance of this in Philadelphia, where very few wells can be accounted good, and this is generally the case with all the towns
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in America. Such inconveniences are not to be met with so frequently in the old towns established by the Romans; for they were so attentive to this point, that aqueducts were built even for very small forts, where a legion or smaller body of troops was to be quartered; hence epidemical disorders raged much less with them. We attribute to the air many great effects upon the body of which we cannot give any good account, but it seems very probable that the corruption or alteration of waters at different times may also have a share as a cause of epidemical disorders.

Such is the human mind in a state of society! In our different inquiries, we direct our studies to unnecessary objects, while we neglect those, which have an immediate connection with our existence.

The mineral waters were formerly as much neglected by us as the common. The ancients left no kind of inquiries or experiments upon the subject; they were, however, persuaded of their efficacy, and Celsus, Galen, &c. recommend them sometimes, as useful and even necessary in different cases. However, nothing interesting was published before the time of the learned Hoffmann, and mankind is much indebted to him for having introduced them properly into the practice of medicine.

*If we compare his analysis with those made by different late authors, we may see what an extensive
field*

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field was opened to the inquiries and genius of philosophers; how many errors were committed upon the subject until this day; and how necessary, curious and useful these inquiries must be. Any body may conceive from what I have observed above, my inducements for engaging in that branch of philosophical research. Being very conversant in it, I thought that my observations on the waters of America might be agreeable to the public as well as useful, especially as the difficulties of investigation are so great, that they will hinder many from attempting it.

I begin with the waters of Virginia, because in travelling through that part of the country where these waters are, I observed the errors of the public, and thought it was time to introduce good principles upon the subject instead of prejudices, which are already too much diffused through the public's mind.

I hope during the course of another year to be able to publish an analysis of some of the waters supposed to be good in the other states, as I intend to give an account of all the mineral waters of America which are esteemed at this time, so that our prescription of them may be founded on a knowledge of their real properties, and the public may have better information respecting a curious part of natural history which is so useful to mankind.

INTRO-

INTRODUCTION.

AMONG the advantages of the soil and climate which nature has bestowed on Virginia, she has not neglected to supply this state with every thing that is necessary to procure to its inhabitants *health*, which is often disordered by different natural causes. But researches into these causes requiring much time, I shall leave the subject for another place, where I intend to speak of the different methods of restoring health, according to the nature and the products of each of the MINERAL WATERS.

THE mountainous part of Virginia, or *High Virginia*, being under a cooler climate, affords to the inhabitants of the lower parts a comfortable difference, according to the heat and dryness it occasions. Hence all the different kinds of disorders, occasioned by the rarefaction of the fluids, and by atony, which occur in this country. These conditions of the body are the causes of a great many different fevers, especially

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ally the Non-humoral Intermittent*, the Double Quartan, &c. which are so common about the end of summer. It is to avoid this dryness that the inhabitants go up the country, to find a cooler air to breathe, and a more nourishing food, which, together with the use of mineral waters that are advised by the learned physicians of the different towns, conduce, more or less, to the restoration of their health, according to their constitution, &c.

To acquire a true knowledge of these waters, and to form a proper opinion of their use in medicine, a good analysis of them by a physician and a chymist was wanted. But the difficulties attending such an analysis were very numerous, and there was no kind of encouragement for it. Hence the many errors which have attended the use of these waters. Physicians could not recommend their use, not being well acquainted with their properties by experiments. The public opinion, therefore, was followed, and uncertainty

* This is a kind of fever peculiar to the low part of Virginia, and which I never did observe in Europe: I look upon it as a symptomatic disorder, if the patients are attentive to have it cured; but it degenerates into a double quartan, or a quartan, according to the complexion and diet which these patients follow. There is no humoral matter at first, but the fever going on, brings more than is necessary for a natural *crisis*.

ty was the basis of the whole matter. Every physician was sensible of the importance of an analysis; but no one would leave his business for a little time to examine the place, and to stay there to make the preliminary experiments, which would have enabled them to establish some certain opinions on the subject.

THE learned author* of the *Notes on the state of Virginia*, seems desirous, for the good of mankind, as well as for the happiness of his country, that these waters should be analysed by some chymist, accustomed to experiments of this kind: and this has also been the wish of the learned in general. No person, however, undertook the task, because the analysis of waters is the most difficult part of chymistry, and that with which a chymist is generally least acquainted, as it respects the science of medicine; and yet experiments of this kind were chiefly instituted by authors for the purposes of practice.

BESIDES the difficulties which I have mentioned, there are some others no less important, such as the expence of transporting an apparatus through a country very disagreeable to travellers. Of these difficulties I was unmindful,

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when,

* Mr. JEFFERSON.

when, at the sollicitation of several gentlemen of merit, I undertook the task ; and indeed, I must confess, that I received every kind of encouragement, from the politeness of different gentlemen, and from the hospitality captain Gurney, of Philadelphia, honored me with, during my stay there.

PHYSICIANS and the learned have never entertained any doubts of the different virtues and of the efficacy of some mineral waters. The ancients, who were much better observers of nature than we, took notice of different virtues and properties in such and such waters ; but not being able to give any account of their different actions, owing to their want of a sufficiency of philosophical experiments, they explained these actions according to the principles which were received in natural philosophy.

SEVERAL authors, after the late celebrated Frederick Hoffmann, examined mineral waters ; but their experiments being difficult, little light was thrown upon the subject, in comparison of what we have derived from more modern authors, or from the new discoveries which have been made both in natural philosophy and chymistry. This science which, in the present century, has arrived to such a degree of perfection, could

could not fail to throw new light upon the subject of mineral waters, which had been much neglected; artists not being fond of operating upon small quantities, and not finding the same satisfaction here as in the other parts of the science, viz. metallurgy, &c. At length the new discoveries of different kinds of airs, opened a new field in chymistry, paved the way to the explication of a great number of phænomena, which had not hitherto been unfolded, and more and more encouraged philosophers to pursue the subject, in such a manner, that it is now as complete as any other in the science.

DR. BROWNRIGG and Mr. Cavendish in England, and other chymists, both in France and in Germany, about the same time observed, that there was a kind of air in mineral waters, such as *Spaw*, *Pyrmont*, &c. After this, the mineral spirit of the old authors, which Paracelsus, Van Helmont, and Becher had called *Gas*, excited the curiosity of the learned in Europe. They now began to apply themselves, and to pay more attention to the subject, which they had formerly looked upon with indifference.

HALES, a learned English philosopher, upon making new experiments on the air contained in all animated bodies in nature, discovered so
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many new subjects of curiosity, that he gave rise to an emulation for researches of the kind. The learned excited by these new discoveries, attempted a variety of experiments. Dr. Brownrigg published in the *Philosophical Transactions*, that Spaw water and a great many others contained a mineral spirit, but without ascertaining of what nature it was. About the same time two authors, Messrs. Venel and Roüelle travelled through some parts of Germany, and discovered that Pymont water contained air of a new kind. Venel, one of these gentlemen, published a result of their joint experiments, without having mentioned his operating companion.

IN this state the discovery and opinions remained, until M'Bride and Black published something curious respecting the air produced by putrefaction, and that obtained from burning lime. These two authors formed a theory founded on new experiments, and then Fixed Air began to be better understood by the learned world.

THIS new phænomenon, after it became well understood, excited a better method of inquiry. In consequence of these discoveries, Priestly began his immortal experiments upon this subject, and the learned of all nations were ambitious

tious to have a share in such important discoveries. Among all these new and curious experiments nothing was tried concerning mineral waters, if we except Cavendish's analysis of the pump-water of London. He demonstrated that there was an aerial acid in the pump-water, and likewise other contents. These experiments were the first, and the best that had hitherto been instituted upon waters in general, and are a rule for any person who wishes to follow this line of philosophical inquiries.

BERGMANN, in Sweden, illustrated this method much farther; and his way of operating may be looked upon as one of the best among all the recent authors, who have followed this kind of researches, so useful in medicine, and so necessary to the human species in the disordered state of health.

ALL those inquiries were a great help to physicians to arrive at a certain knowledge upon the matter and to judge better of the virtues and application of mineral waters in different cases, where their patients may be in want of these salutary, natural remedies.

WHATEVER may be the opinion of some people about the matter, and their doubt respecting the
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the properties of waters in general, it is by analysis alone that all these doubts may be removed, because what falls under our senses, is a demonstrative proof against incredulity.

THE medical observations which were made centuries ago, proved the contrary. We have therefore a right to conclude upon the subject, after a good analysis, by which we discover the different principles of any body whatever; and if the chymists do not always pronounce directly upon the application of such or such waters, their compound being explained, they acquire a sufficient authority to do it, especially when they are practising medicine at the same time. To deny that authority to chymical researches, which are known to be so useful and necessary, since medicine follows the laws of natural philosophy, would induce the incredulous to shake the foundation of the best theory, and refuse that certainty to a science so able to illustrate by its own knowledge all the different branches of society, and introduce ignorance instead of learning.

THE incredulous, in vain, exclaim that there is no comparison between the small quantities of some parts of a saline substance and their action upon the animal œconomy: daily experience, however,

however, will convince them fully of the contrary, if they are not obstinate. If philosophers had sooner applied themselves to the subject, and had reflected upon the different mixtures of salt contained in waters, their division, the large quantity of them drunk by patients, before they found any relief from them: if physicians, after these observations, had administered the same substances, in proper doses, with the same patience, in the same cases; if patients were not anxious to be cured in a short time of a sickness of long standing, then it would be more easy to come to a good rule respecting the use of the same substances, and that would lead us to discover a new method of curing, sooner and quicker, such disorders which would otherwise resist the common way, used even at this day.

THESE observations were made by skilful physicians, who were desirous to find out the same salts, the action of which they found more powerful; but *ignorance*, contrary to their view, always opposing her sister *incredulity*, together *they* overturned the best ways and plans which were proposed to ruin *their* dominion over the greatest part of the world.

EVERY body knows that as soon as a new discovery is published, it is directly opposed by
 B ignorance

ignorance and incredulity. I hope, this will not be the fortune of this essay. I am not afraid of critics. I have attempted to find out a truth useful to *mankind*, and inquiries after truth are my *object*. If I have been mistaken sometimes, others, upon new experiments, will discover my faults, and rectify them for the sake of the human species.

THAT I might be better acquainted with these waters and their principles, I examined with care the place in which they run; because the natural history of their situation assists us in forming a conclusion, determined by various experiments, necessary for that purpose. All the contents of these waters exist near them, or a very little way off; and even a naturalist could almost conclude upon their nature, if chymical experiments were not the only way to prove the existence of what the naturalist has only a suspicion of.

ALL these seats of ruined mountains, one upon another, are very curious: their irregular formation, their new materials, afford a good many reflections to the observer who chooses to pay some *attention* to them. *

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* These observations will be published in a treatise on the natural history of the United States.

IN order to come to a better idea of the different substances contained in these waters, I followed the process formerly used; afterwards I tried those employed by recent authors, who use the new theory of airs: the results were pretty nearly the same. I shall only relate here that method which I followed a long time ago, as being at once the most concordant with the new theory, and more certain in practice. The *aeriform* fluids being some of their most curious contents, I demonstrate that such waters contain such and such species, but without ascertaining the quantity, for want of a proper *apparatus*; and as it belongs much more to natural philosophy, I leave it to the care and ingenuity of learned gentlemen in this country, who will make addition to what I have begun, only with a view to public utility.

I BEGAN by exposing each water to a gentle evaporation, in glass vessels or in earthen ones, and repeated the same in better ones at home. *Balneum mariæ* was the degree of evaporation, and whatever might be the error attributed by certain authors to *analysis* by fire, when it is properly managed, there is no difference perceptible; and the supposed errors are more in opinion than in fact. However on proceeding in this way, I found no decomposition, no al-

teration, and the products were the same; I must confess too, that great care is to be taken to keep a constant graduation, and the *balneum* should always have the same quantity of water boiling. By these means the water evaporates slowly, and you may obtain the earthy products about the middle of the evaporation.

THE difficulty of carrying so far, by *bad roads*, proper instruments, is a great obstacle to a multiplicity of experiments; and of those I had along with me, I was obliged to use what I could, sometimes for one thing, sometimes for another. As for the degrees of heat, &c. I refer the reader to the learned Jefferson's *Notes*, and the learned *bishop* Maddison's paper, published in the *American Philosophical Transactions*, vol. II.

THAT gentleman, on his tour, had a very good thermometer, &c. and mine being one of Reaumur's, I rather choose to follow Mr. Maddison's; observing that hot water and *warm water*-springs are not different in so great a degree as is thought by every body.

THE method of collecting products by precipitation, as proposed by some gentlemen in Europe, I have often tried; it would not succeed, or else it would have saved me a great trouble:

trouble: that method will do only for earthy precipitates, and I rather chose to collect them by evaporation, than by any active precipitant, the separation being afterwards difficult and uncertain; and if this method were to be adopted, it can not be but upon large quantities, which is still more difficult. To be certain that there was no error, they have been obliged to repeat the same experiments many times, because sometimes there are accidental products with the natural ones; these waters being subject to alterations, according to the state of the atmosphere, as in damp, rainy, stormy or cold weather, and when the heat is more or less moderate. These observations remain to be made, and are worth the attention of a good philosopher.

IN general, some waters follow the temperature of air, some others not, as sulphurous springs; but those which contain a calcareous earth, combined with *aerial acid* alone, are rather cooler than those which contain another kind of air, mixed without aggregation: I observed, a good many years ago, these differences; but this is not the place to speak of them, for fear of being too long.

WATERS which contain inflammable air, with *aerial acid* in combination, are rather
warm

warm in proportion to inflammable air, which alone makes the difference between the *sweet spring* and the *red spring*: the first contains aerial acid and *inflammable air*; the second, aerial acid combined with iron in two different states, to be explained in its place.

THE first of these waters is by some degrees of heat warmer than the other, loses its principles a good deal quicker, and is more difficult to be exported from the place; however all of them may be exported by taking some precaution.

THE other method I used was by *re-agents*: this is the common way of attempting to acquire some idea, respecting the contents of any kind of waters; but it is more advantageous in trying common waters than mineral ones. I did not obtain as much satisfaction by re-agents in general as I thought I should: therefore, I never tried but seven of them, which I found to be the only necessary ones for preliminary experiments. Authors do not entirely agree, which to prefer: every one has his own to which he is used, and extols it; but, in truth, I do not find more than seven re-agents, which may deserve that name; and all of these are not necessary at the same time: however, as they are used all in the common way of analysis; I employed them

on this occasion for want of some other things, which I could not find on the place.

THE way of analysing *liquids*, as waters, by *re-agents*, has been introduced in chymistry, as all errors are, slowly: chymists thought they could discover a great deal directly, under a kind of mystic operation; but it is nothing more than a conjecture. The learned in that science fixed upon some experiments, as the action of galls dissolved in water or spirits, to know if there was any iron or not contained. The theory of airs brought lime-water to be a certain test of the presence of *aerial acid*; and at last the learned Bergmann brought in the *acid of sugar*, to ascertain the smallest quantity of lime contained. These *re-agents* do not always give a true result; but they assist us in discovering, that there may be such a substance to be tried by other ways, used and known in chymistry.

I FOUND, by a great many analyses, the uncertainty of these experiments, and how necessary it was to discover a better way; and all experiments in chymistry having different results, they ought to be tried by all the different methods known in the science. For instance, it is not enough to be persuaded, that a water contains an alkali, it is not enough that a liquor
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be turned to green, or any other color, according to the re-agent I may employ: some other methods are necessary to determine, whether there is an alkali, or not, and to discover of what kind that alkali is, &c. It is not enough, neither, for a water to turn yellow by pouring the solution of a metal into it, to believe that there is some vitriolated salt, if by different experiments I do not prove of what nature the said salt is.

IN general, I look upon re-agents as being almost useless and unnecessary for analysing of mineral waters; and I think they are merely amusing experiments, affording no knowledge of the compound, unless the chymist is particularly used to experiments in chymistry. It is on account of this difficulty, that mineral waters were that part of the science which was neglected, till the modern authors began to bring in a new light.

FROM the numerous experiments made by the learned of different countries, it appears, that chymistry has a better method, and more certain experiments upon the subject. There will always be very difficult points to determine, especially when the chymist himself can not go to the place, and try there such experiments, as are fruitless and uncertain any where else, &c. Every body knows the consequence of this, because

cause there is a great difference between a water carried away to a great distance, on account of accidents of all kinds. The patient, however, does not regard these little differences, provided he is sure of finding a relief to his pains, and a certain action upon himself, to bring about a cure, either complete or palliative.

It is, then, the duty of physicians, in general, to observe the patients to whom they have prescribed waters, and to judge from them, what kind of alteration their use has made, and they will then be enabled to determine, by the composition, how to direct themselves in a great variety of cases, on beginning a cure at home, which is to be finished by waters. The practice of medicine will enlarge a great deal, upon enquiring into the different kinds of disorders to be cured, and knowing, by observation, the various effects produced. Then, theory, having observation and practice, would be grounded upon a solid bottom. For the benefit of mankind, it would be even necessary, for some time, to settle there a good observer, to reduce into tables all the diseases coming there, and to note the effects of the waters, to direct the patients to such or such, and to follow constantly the direction of nature. Such an establishment, for three years, would be more useful to society than twenty

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battles; the art of saving one being more necessary than that of killing a thousand.

ALL the indications, which I offer to the public, in this book, are not only made upon observations, and reflection, but are founded upon the natural composition of each water in particular: hence, after the analysis of each water, I intend to give its way of operating in medicine, and its indication in different disorders. Physicians will then order these waters, according to the peculiarities to be met with in the course of their practice.

THE diet to be followed on using mineral waters, is a matter not to be neglected by physicians. It often happens that disorders very easy to be cured at first, turn out differently for want of a proper diet; and as it is frequently in desperate cases that patients go to waters, the least fault in diet is very prejudicial, and destroys entirely all the benefit produced by the waters. A moderate diet is the only which is proper; high living will never render a constitution healthy, much less on using mineral waters.

THE chronic disorders are much more frequently to be cured by mineral waters, because these disorders require something particular in
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living, and being in general left to nature for their end, the drinking of the waters often completes a cure, which was begun by the common remedies in medicine.

THE history of each water will form a chapter of this work, that the reader, who wishes to be acquainted with one or the other, may find it apart, and satisfy himself by acquiring a perfect idea of it.

A COMPLETE
T R E A T I S E
ON THE
MINERAL WATERS OF *VIRGINIA*.

C H A P T E R I.

*Analysis of the acidulous Water, (commonly called
Sweet-Spring.)*

THE situation of this spring is between two small mountains, in a little valley in the county of *Bath*, and state of *Virginia*: the water springs out of the ground in great plenty, and makes a stream strong enough to move a saw-mill and grist-mill. A little way from its source, it may be considered as a small river, falling into one of the branches of *James-river*. The situation being quite low, makes it liable to be mixed with a run of water which spoils it; and there being no bafon, the walking about
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it makes the mud fall into it, to the great inconvenience of those who drink the waters. The ground is soft and tremulous, incumbent upon a marshy mud; which is the cause of its being not very clean: another cause is this, that the bath is quite in the middle of the spring, and people drink the waters, whilst others bathe in them; so at least it was when I was there; things, however, I hope, are altered. A very small expence would put up the place in good order; If this is not done, the great number of inconveniences will turn it into discredit, should the public be well acquainted with them.

ALL the different substances, composing the soil, are an indication to the naturalist, that he is in a country formerly altered by great revolutions. The mixtures of old and new revolutions are present; whether they have been rolled about by sea, or made by it; at least it is certain from the nature and composition of the earth, stones, fossils, &c. that this part of the mountains is older than any of the adjacent ones. Each side of the mountains is covered by *free stone* (*cos communis*); some other parts are a kind of *jasper*, variegated with white lines; and the basis of the whole mountain is a hard earth, composed in general of *clay* and *limestone* in different proportions, mixed with iron and colored by it. There

is a constant observation to be made here, viz. where we find the loam *argilloso-calcareous*, the waters are much more impregnated with aerial acid; and on the contrary, where the waters come out of a *free stone*, *cos* or *quartz*, they are cooler, and contain less of this acid; because they run through, or over, substances, which alter them.

THE whole valley becomes wider, in consequence of the accession of the waters of the spring, and the waters being almost upon a level, stagnate there. A good many small springs are adjacent, and being mostly upon the edge of the principal spring, receive at once the waters of the marsh and mountains, by natural declivity. The sediment of the waters has partly filled up that valley, and it is full of *selenites*, crystallised like *stalagmites*, and underneath it forms crevices or small caves, which extend a good way under the ground, and sometimes break and sink down, as I have observed near a place called *Beaver-dam*. There is no safety in building upon these places. The crystallisation being in a confusion, there is no identity but only a *juxta position*, and the rain-water coming through carries away something, and divides each crystal in such a manner, that in succession of time, the falling of trees causes the excavations to break.

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THE reader will conceive that formation better, when he shall be acquainted with the quantity of earth these waters contain, which they lose on running down. Aerial acid being the dissolvent, and having more affinity with atmospheric air, leaves the earth, which settles upon all other surrounding substances; as stones, leaves, branches of trees, which is a great curiosity. All these singularities are to be seen at the mill, and at the *Beaver-dam*, (upon *Spaw-spring-ground*) a mile off. The falls of water at these places are delightful and very curious; and the sediment is a proof of what is lost by evaporation in the space of two miles. There is another dam, lower down, much larger; but its products are not so fine, because the whole waters of the valley unite there in a fall, and form a branch of a river: the water then becomes soft, dissolves soap better than before, on account of the quantity of earth which was dissolved by the aerial acid being now disengaged, which makes the water better for any uses of human life, &c.

If we dig in any part of the *marsh*, we shall find the water impregnated with the same principles, and directly a great quantity of bubbles of air rising at the surface, and succeeding one another very rapidly. They are aerial acid, mixed with a little inflammable air produced by the
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putrefaction of vegetables in the marsh. This small portion of inflammable air gives to the waters that putrid taste, suspected by the public to be owing to *brimstone*. This taste soon dissipates, if we let the water stand a little while; the want of a proper apparatus here hindered me from ascertaining the exact quantity of these two kinds of air, especially the *marsh-air*: but the discussion of this point would be too long for this book, and these inquiries belong more to natural philosophy. Others will do it after me, a man being not able to do all at once; therefore I hope the reader will excuse that omission, till a new edition, my intention being only to speak of such properties as are useful in medicine, and to the health of mankind.

THERE are two ways in chymistry to proceed to a good analysis; one by re-agents, which are different compounds we add to water to alter the aggregation of other bodies, and the other is fire, which by its gentle heat evaporates all the liquid, and leaves behind all the solid substances dissolved in the same.

By the first we may (being accustomed to such experiments) guess that there is a substance of such and such a compound nature: by the last, the compounds, when they are not

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volatile,

volatile, may be collected together and afterwards divided by other processes known in that sublime science, by which we may find out the smallest parcels of bodies in nature.

THESE are the two ways which I used in this analysis of the acidulous water; if I have not attained the whole knowledge of it, some philosophers, after me, can make an addition to what I could not have discovered, or what I have neglected.

I NEVER use more than *seven* of the re-agents mentioned by all the chymical authors; the others being too numerous, uncertain and useless. These seven are, a *blue infusion* of flowers, no matter which, provided it is good (that of violets is what I used) the two fixed alkalis; solutions of mercury and silver in the nitrous acid; the tincture of galls; and lime-water.

THE water is whitish and clear; has a taste acidulous and *sulphureous* after it is drunk; its temperature is warm, and in summer it follows the temperature of the atmosphere; a great quantity of an elastic fluid is continually escaping through it in bubbles. The learned Mr. *Maddison* collected some in a bladder, and upon agitating it in water, found it was fixed air; the taste was acidulous,

dulous, which is a proof; but he took no notice of the small quantity of inflammable air produced by the putrefaction of vegetables, &c. It does not feel heavy in the stomach, whatever action it may have upon that organ; sometimes it occasions a light head-ach after it is drunk, a property common to waters in general, containing either *hepatic* or *inflammable air*. But the headach soon dissipates, especially when any function of the body is beginning to operate, as *sweat* or *urine*. It is proper to observe that very weak stomachs feel a heaviness at first; but if the patients are moderate in the use of the waters, and their diet, this heaviness soon goes off.

THIS water sometimes brings on a looseness, which is more beneficial than disagreeable: those who are affected with costiveness will be obliged to make an addition of salts to help nature to perform her functions, because a good digestion depends a great deal upon a proper state of the intestinal tube.

I SAW at the spring some gentlemen drinking an excess of the water, who in consequence were seized with an atony of the stomach, to such a degree, that they were a whole week in repairing the strength and the tone necessary to the functions of that viscus. Hence it follows

that we should not make too great an use of them, but drink them moderately, and use a middle diet, then a patient is sure of recovering very easily.

EXPERIMENTS BY REAGENTS.

1. ON pouring a few drops of the tincture of galls, in a little time I observed an iris-like pellicle; and the water was only tinged with a light purple colour.
2. THE mineral alkali being mixed with the water, formed a granulous precipitate, composed of an earthy substance.
3. LIME-water precipitated a white substance, which carefully collected, seemed to be lime that was before dissolved by aerial acid.
4. VITRIOLIC acid made a great many bubbles of air come out.
5. A SOLUTION of mercury in the nitrous acid, afforded a yellow precipitate.
6. A SOLUTION of silver in the same acid, formed a whitish precipitate, which soon after assumed a purple hue.
7. THE tincture of violets was sometimes altered to a red colour; this, however, was not constantly the case.

THESE

THESE are the principal results of the experiments which I attempted by re-agents: a great many others I omit here, as unnecessary in this publication; all these experiments I repeated many times, in order to discover if they were constantly the same; and however constant they were, I could not be certain of the contents, had I not employed the other way, of fire, in proceeding to a kind of decomposition or separation of the whole.

FOR this purpose I evaporated, in a proper vessel, in *balneo mariæ*, two and twenty quarts of the said water. The fire being put under and the *balneum* being half boiling, common air first came out in *bubbles*; but when the water grew hotter, more of an aeriform fluid came up. Upon collecting this air, it proved to be aerial acid, by all the common experiments used spoken of before, and when the *balneum* was boiling, there came out much more, till at last a thick pellicle was formed on the surface of it, and very little air escaped afterwards. This pellicle commonly breaks of itself in scales, and falls to the bottom of the vessel. The evaporation being carried on until it was reduced to a quart, there then appeared a yellowish colour which was probably owing to iron. The water being evaporated to this degree, still retained an
acidulous

acidulous taste; and on continuing the evaporation, it went off entirely; this last portion of aerial acid is in a true combination with iron and a little earth. This is the reason why it appears a little turbid, and whitish. Besides the white pellicle forming at the top of the liquor, there is another part of it which falls to the bottom, and sticks very hard to the glass vessel: some experiments prove it to be rather the *calcareous mephite* and a very little *selenites*.

THE evaporation being carried to a sufficient point, I put the whole into a bottle well corked to take along with me, and try some more experiments at home. On opening the bottle it smelled a good deal of rotten eggs, (or what is called *bepatic*,) stronger than it was at the springs: and a bottle of the spring-water had hardly any smell, but was acidulous. The residuum of the first evaporation was quite black, the end of the cork of the same color and covered with small crystals.

I EXPOSED this water to a new evaporation: some bubbles came out, which were swimming upon it: the smell soon went off, and the whole being reduced to dryness, I attempted the separation of salts, to know them better one from another. I poured on the whole a portion of distilled water, and repeated it till the water
seemed

seemed to dissolve nothing more. Then I collected these lotions, and proceeded to a new evaporation, till it was brought to the degree of crystallisation: I took it out and left it to crystallize: the liquor was of a brown color, making no kind of effervescence with acid or alkali, and forming no precipitate, which were proofs that the salts were perfectly neutralised. On following the evaporation, a saline substance adhered to the glass vessel, and was spreading over it, a sign that there were salts of an earthy combination present. All being dry, and the crystallisable salts a-part, if we add an acid there is an effervescence and something remains untouched. With the *vitriolic acid* there is a solution of calcareous earth; and what remains is a little of vitriolated tartar, and siliceous earth.

THE crystals obtained are evidently *epsom salt*, or *vitriol of magnesia*, and some crystals of marine salts; this is the reason why the residuum of evaporation had a saltish taste. After the whole evaporation the marine *calcareous salt* remains in the waters. This is the cause of the attraction for dampness when it is left by itself in the open air.

HAVING discovered the different saline substances contained in the water, I am next to explain what kind of earth there is which could
not

not be dissolved by the distilled waters, and remained upon the filter.

I FOLLOWED the way of distilled vinegar to dissolve the calcareous earth, and make a *foliated earth* or *coralline salt* of a scaly figure. The liquor being evaporated, afterwards gave no crystals, and is thick. Then on precipitating it, it is found to be magnesia, which was in the water in a perfect combination with aerial acid. On entirely drying up the *residuum* left by the acid of *vinegar*, there remains a quantity of earth which is not acted upon by acids: it is siliceous earth, sometimes mixed with a little of clay. As for the iron contained, I separated it by the filter, and found it to be from 1 gr. to $\frac{1}{2}$ gr. according as the water was taken in clear weather or not.

HENCE it follows that the acidulous spring in Bath county, contains in the quart:

Of saline substances in general,	12 to 15 gr.
earthy substance,	- - 18 to 24
iron,	- - - - 1 to $\frac{1}{2}$

IT is surprising to find in this water such a quantity of contents, but on considering its situation, in a valley where rain-water carries all kinds of things, adjacent to a marshy place, where putrefaction yields a large quantity of acid
air

air fit to dissolve these earthy substances, where sulphur, spread in pyrites, as well as in rotten wood, is constantly operating new compositions and decompositions, with all the substances it has attraction to, it will not be difficult to find out from where all those contents are derived. How they are produced will be very easily known to any philosopher accustomed to observations on mountains.

THE inflammable air being obliged to make its way through the water, impregnates it with the same hepatic smell, which is sometimes produced in putrefaction, as in that of eggs. However, I would not persuade myself that there is no hepatic air, because sulphur is to be found there in plenty enough to give suspicions of it. But these particulars belong more to other researches. This uncertainty respecting the presence of hepatic air, appears much greater upon examination of another spring close by. In the selenitous sediment of this spring, where putrefaction has no communication, the water is *acidulous*, and has no hepatic taste. Its situation is something higher, out of any run of rainy water, in open ground, more exposed to the sun. This exposition makes the water somewhat *white*; hence it was called *buttermilk*. A good deal of the aerial acid escapes into the atmosphere; the

E calcarious

calcareous earth being deprived of it, swims in water, and gives it the white appearance. Being tried by re-agents, it afforded the same result, and is the same with the other in every respect, except in the quantity of acid and in taste.

Now if we recollect the bottom ground of the whole valley filled up by the sediment of waters or *calcareous mephites*, or *selenites*, it is not surprising to find the same substances in water as the basis and some other accidental contents, which are produced by all the surrounding substances of different natures. The presence of sulphur in putrefying vegetables and its re-action in other substances, give the aerial acid and inflammable air, which make new compounds, &c. in such a manner that there is a constant action and re-action of substances and new compounds appearing, the formation of which is easily accounted for by a learned observer.

If we receive the inflammable air coming out of the marsh without crossing a large spring, we shall find aerial acid in a smaller proportion, but at the same time it does not smell so much of sulphur. This experiment naturally accords with the new theory of the composition of water, so much spoken of some years ago; and I think I shall soon demonstrate the daily formation of
waters

waters in the mountains of Europe, and in those of America: some few more experiments upon the subject will bring the demonstration to a conclusion.

BEING now acquainted with the natural and chymical history of the acidulous waters, and being certain of their principles, it will be easier to ascertain their use in medicine in general. I leave it to physicians and experience to determine more particularly in what kinds of sickness they may be better applied, after knowing in general the constitutions of the persons, who want to make use of them.

ALL saline or earthy substances have pretty nearly the same effect and tendency. They are in general laxatives, promoting some secretion, either that of perspiration, or stools, separately, or sometimes two secretions at once. Consequently, there will be a good evacuation, according to the fulness or *plethora*, especially if we consider the quantity of earthy and saline substances which these waters contain. The contrary happens, when there is no rule observed by the person using of them, because if the stomach does operate well, the bowels follow the same laws. But many times, instead

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of

of having a tonic effect, they induce a general relaxation.

I OBSERVED two or three cases of this kind when I was at the springs. I saw a gentleman in a very desperate situation, from a weakness of the whole body, proceeding from a general relaxation of the system; he was in the use of these waters, beginning with a few glasses, and drinking no tea afterwards. At last he drank about two quarts in a day, and recovered entirely, and went home satisfied: but now and then he took some gentle remedies to assist nature and the operation of the waters.

THE excessive use of this water produces the opposite effect; and when drunk after meal, it works differently, because a remedy that is innocent, when taken on an empty stomach, produces a bad effect when that organ is full, &c.

THE kind of salts of which I spoke before, are the substance upon which chiefly depend all the virtues and activity of this water: it will be enough then, to explain in general, in what kind of sickness it is necessary.

AMONG all the different disorders to which mankind is liable, there are none of longer continuance

tinuance, and more tedious than what are called chronical disorders. That extensive class of disorders is more the object of mineral waters than any other; acute disorders cannot be cured by them, except by the inhabitants of the place, because these disorders are seldom of long duration. It follows from thence that all kinds of *languishing* situations, remaining after fevers, whether acute or intermittent, may be relieved by using this water, and following exactly the direction of a good physician. If there are any obstructions of the viscera, they must first be attended to, in order to prepare nature for a revolution necessary to accomplish a complete cure, without any danger.

ALL disorders having a vice of the humors, as, a viscosity of the lymph, *king's evil*, simple or complicated, may be begun with success, and be finished by other waters, the acidulous being not able to complete the cure. All kinds of swelling of any of the viscera without scirrhusity, as, swelling of the liver, spleen, pancreas, mesenteric glands, may receive great relief, some be cured, some others not, according to the duration of the sickness, the hardness and the bulk of the swelling, which many times, for want of action, hinder physicians from undertaking a solid cure.

PERSONS

PERSONS subject to an extraordinary heat of body, as of the bowels and different parts, may be cured, and escape great accidents, which always follow these dispositions. In these cases, a proper use of the water and of the bath, relieve them entirely. Some patients require now and then to be assisted by remedies, of a kind, suitable to their sickness, as *purges, tonics, &c.* or else they remain weak after using the waters.

THIS great phenomenon of the human œconomy deserves great attention; because if the heat is too great, the body remains weak. All the system of nutrition is suffering, if not sufficient in proportion, there happen more accidents, as heaviness, languor, till that function is restored, or the critical matter is carried off by another secretion in a larger quantity.

THE first part of this observation is more applicable to the people of the southern states, where the perspiration being great, and the body weak, nutrition has hardly time enough to be operated, so as to supply what is necessary to the strength of the body. This is the reason why they are in general, thin, weak, very often sick, and fall into consumptive disorders, &c. The contrary happens in the northern states to the greatest part of the people, nutrition being there

in

in proportion more than the body has occasion for; hence very fat persons, and very frequently acute fevers almost as dangerous as in Europe.

THIS theory being well known, nobody will think it extraordinary, why the Virginians on going up the mountains, will soon repair more substance, and be fatter there, than they can possibly be lower down. They soon repair their weakened stomachs, hence all the strength of body: they recover as soon as they have entered the mountains, where they find exactly the opposite of their native places, in which the surrounding things have a propensity to destroy all the bodies living by fluids; the rarefaction of blood, heat, hot winds, &c. all have a tendency to evaporation. In the mountains it is quite otherwise: all has there a tendency to keep fresh and cool: hence, their better health, because there is little or no sweat, perspiration being moderate and equal, and the organic functions better: then the harmony of organized beings is more complete, and constitutes health, especially when the people join to it that fine virtue, *frugality*.

THE people of the mountains, however, are very often sick, and as often as any, because of their way of living: I observed among them a
great

great number of cafes of rhuematism, obstructions, eruptions of different kinds; and acute disorders more frequent; I infer from thence, that there are pretty nearly as many patients there as any where else; but I repeat it, their way of living is the cause of it. The Germans who live in a better way are not liable to so much sickness, their industry preserving them better, however liable they may be to the infirmities incident to mankind.

CHAPTER II.

Analysis and natural history of the spring called Red-Spring, but which would be more properly called Spaw.

THIS spring comes out of a kind of *rock* of the *argilloso-calcareous* kind, spreading from the mountain down the valley, which produces acidulous waters all over. This stone is sheeted like, compact, but is softened a great deal by exposure to air, and breaks easily afterwards: the interstices are often filled up with an *ochreous* earth, left behind by the waters and the loom between the crevices: it is of a *marl* nature and *ferrugineous*.

THE

THE water going through all these interstices containing aerial acid, carries along parcels of the iron, which precipitate as soon as there is any contact with the atmosphere, when another part remains in water in a solid combination with the acid. The superfluous iron settles upon any surrounding bodies under its native color of a fine red *crocus*. This appearance was the cause of the name given to this water of *red chalybeate water*; but it does not contain, in fact, more *chalybs* than any other; the difference is in the two ways the aerial acid dissolves iron, as it has been published by Mr. *Lane* and *Roiëlle* in the *Philosophical Transactions* for the year 1770.

AMONG the variety of waters which I tried, I found none that comes nearer to *Spaw-water*, consequently, as it is a well known name I thought it better than that of *Red-spring* which in itself is accidental, and not founded upon its nature. This water, when drank at the spring, has a very light, acidulous, chalybeate taste, mixed with something putrid; which taste is frequent in all springs containing iron, and is owing to a phænomenon, the explication of which would require more time than I can devote to the subject in this place. I believe, however, it depends upon a reaction of the two airs upon iron, &c.

THE waters leave no kind of astringency upon the tongue, and do not dissolve soap. Close by in the marsh, coming out of the hill, are other springs of the same nature, and some exactly like the acidulous water, spoken of above.

EXPERIMENTS BY RE-AGENTS.

1. ON pouring into this water some drops of the tincture of galls, it produced a purple hue, which became a little more colored upon standing four and twenty hours.
2. THE vegetable fixed alkali precipitated a white powder, and air was observed.
3. MINERAL alkali produced the same effect.
4. A SOLUTION of mercury turned the water yellow; which renders it probable that there are some vitriolic salts present.
5. A SOLUTION of silver disturbed the water very little: after a long standing it looks only a little pale, but gives no sediment. This seems to be a proof of the presence of a very small quantity of muriatic salts.
6. LIME-WATER produced a white precipitate; which is a proof of the presence of aerial acid, disengaged from its basis.
7. IF some drops of an acid are poured into the water, there is no kind of motion. This
leads

leads us to suspect there is no kind of alkali present, which experiments will prove to be true.

IT is very easy to see, from these experiments, that there is nothing certain respecting the contents of the water; and this analysis by fire will prove sufficiently.

I PROCEEDED in the same way as before, and exposed about ten quarts to a slow evaporation, in *balneo mariæ*. A great number of bubbles of air came up, which upon being collected in a bladder, were found to be aerial acid, by all the experiments proper for ascertaining this point, and which are too long to be repeated here. As it escapes from the water, a white pellicle is forming at the surface, composed of the calcarious earth left behind by the aerial acid: when all of it is dissipated, the pellicle falls down in fragments of different sizes.

IN the progress of evaporation the water does not change at all its color; this is only the case when it is reduced to one half of its bulk; then it turns yellowish, and the iron contained begins to separate. This progression seems very exact according to the quantity of acid in the fluid; those substances which contain most of the acid,

lose it first, and others afterwards. This observation is a proof of what I said before concerning the two ways in which iron is dissolved in water; namely, a suspension by the aerial acid and an intimate combination by the same fluid. At last, on following up the evaporation, the water assumes a deeper color, till all the iron falls to the bottom, or swims in it, or till all the water is dried up.

I PROCEEDED, as before, by lotions with distilled water, and having evaporated all together to a point of crystallisation, I found, some days after, crystals of different forms, as selenites, vitriol of magnesia, and a very few crystals of marine salt.

THE earthy residuum being dried, I poured into it distilled vinegar, and the greatest part of it was dissolved; being evaporated to a crystallisation, it was found to be coralline salt. The mother remaining after crystallisation being precipitated, gave an earthy substance, which proved to be a magnesia, which had before been dissolved by aerial acid. There remained upon the filter that portion of iron mentioned above. These are the processes by which I came to an exact knowledge of the contents. I tried a good
many

many other experiments to come to that point, which it would be tedious to relate, and useless to the reader.

IT follows that this *Spaw water* contains, by the quart, as follows, viz.

Of aerial acid,	-	-	-
calcareous earth or lime,	-	-	4 gr.
aerated magnesia,	-	-	3
iron aerated,	-	-	2
selenites,	-	-	1
vitriol of magnesia,	-	-	1
cubic muriatic salt,	-	-	$\frac{1}{2}$
iron combined,	-	-	1

UPON seeing this table, no body will be surpris'd at the great quantity of substances contained in this water: and it would be more acidulous than the first spring if the superfluity of aerial acid was not taken up by the iron; such is the bulk of aerial acid in these waters till it comes in contact with the atmosphere; without this happening, the water would be as acidulous as *Pymont*, or at least as *Gronstein-water*, which is sent about for *Spaw-water*. The acidity would be greater, again, in the *sweet spring*, if the inflammable air did not alter it.

BUT

BUT to return, the inferior part of the hill of argilloso-calcareous stone, contains a good deal of martial *pyrites*. Being broke into pieces, and left to *flake*, as it were, and put afterwards in any water, it impregnates it with the putrid iron taste, spoken of before. It is not then to be wondered at, how waters, running through these *pyrites*, may contract that taste, especially on account of their containing airs, very attractive of dampness, or fluids, in general.

BEING now acquainted with the principles contained in the *Spaw-water*, I may very well deduce their application to the animal œconomy; and physicians, according to different cases, may advise them as salutary remedies, either by themselves, or assisted by other remedies. Active substances in this water are four in number, namely: aerial acid, magnesia, vitriol of magnesia, and iron. They have all the same properties, in general, moderating one another, as *stimulants*, *tonics*, and *antiseptics*. This is the reason, why in *weak stomachs* and *bowels* they are mild purgatives, and when the tone is restored, they become astringents. If there is any *acrimony* or *sourness* of the *primæ viæ*, they relax, &c. They prove very effectual from the acid, leaving the earthy substances to form a new combination. When the aerial acid goes
off,

off; then they must be applied in cases of relaxation of the whole system of the *belly*, whether it is in the stomach, bowels, or other parts. A moderate quantity will operate very well: a too great one will increase a slow circulation of the mesenteric system. Sometimes weakness after a long sickness may be altered with great success, on drinking a little at once, using a moderate exercise, and a sober diet, and no tea, unless made with bitter plants, &c. otherwise internal obstructions, &c. will often be the result of error.

THOSE patients, who wish to drink this water as a tonic, must previously be purged once or twice, afterwards they should bathe three or four times; then begin with a pint in the morning and one at night, eating no supper, drink small glasses at once, and conduct themselves in such a manner, that all the water may be digested before any meal. The contents of this water being most constantly the same, I think it ought to be considered as the best of all. It comes out of the rock, and has no kind of impurities as the acidulous; it is something cooler, and its situation is in a place much less alterable; the same ground contains acidulous waters of the same kind, and they might frequently be mixed, either together or separately, in wine, or in any other drink.

THIS

THIS kind of water is more certainly adapted to the constitutions of this country, because there is but one kind of *air* contained in it, which cannot be disturbed by the accidents of the valley, as putrefaction, &c. inconveniences to be found in the other spring, as I explained above. It only remains for the owner to provide accommodations as good as possible, that every body may find the difference, naturally existing between the two waters, but unknown to the public, who are apt to follow what has been before considered as rules, that are often very bad, and contrary to the views entertained by patients on setting out for the springs. There is yet to be observed, that this water, when left by itself in a bowl, will lose a great deal of its strength, which some stomachs can not bear, because iron disengages itself from a great part of the aerial acid, which going off, the water then becomes lighter.

THERE are a great many other experiments which I made, concerning the practical use of these waters, but they are too long to be mentioned here, and would be too tedious to the reader.

THIS water may be carried any where in the United States, on taking particular care for the purpose:

purpose : it retains all its taste. I carried some bottles down with me, and one of them, three months after, was as good as when I put it in the bottle, and being analysed for a point of comparison, I found in it pretty nearly the same quantity of aerial acid. This is a great proof of its more intimate mixture, and of a good aggregation of the whole. This water has, then, over all the others, the rare advantage of being fit to be transported any where we may desire. The others lose a great part of their aerial acid, and then they become disagreeable. I believe, however, they could be managed in such a way as to render them transportable.

It is probable, the owner of this place, being a gentleman of fortune in *Philadelphia*, will do all he can for the best accommodations, and will establish more baths, and a pump or a basin proper for the people meeting there to drink the waters, and have the benefit of the whole ; a little decoration, and more conveniences, such as seats, steps, &c. are necessary to give an easy access to this place, to be out of the sun, rain, &c. which spoil water.

PHYSICIANS will afterwards settle a proper diet for their patients going up there, because every thing is not to be found in plenty in a country

so little inhabited, and where the inhabitants having hardly enough to supply themselves, can not spare much for the great number of people resorting up every year. If the inhabitants of *Green Briar* did not bring their provisions to the bath, the springs would not be supplied. I must inform the public, that all the waters which come out of the meadow, in different places, are of the same nature, and only vary in the quantity of their aeriform fluid. I tried about a dozen of them, in different places, and in the same place there are a good many other springs, but which do not always contain the same proportion of substances, so as to bring them to any comparison with one another.

CHAPTER III.

Of the Hepatic-water, called Sulphureous.

ON crossing a middle ridge, called by the inhabitants *Alleghany*, there begins the county of *Greenbriar*, situated in a valley, which is very large, and very fertile. It is the last inhabited country in this direction to *Kentucky*. The waters coming out of this ridge, turn west, and fall into *Greenbriar-river*, and this again
into

into the *Kannaway*. After having crossed a great many mountains of different heights, but low; all of them composed chiefly of freestone of various colours, intermixed with *schistus lamellaris recens*, and following then a little stream coming out of the said Alleghany very low in that place, the brook comes out of a kind of freestone mixed with *mica*, which is very fine. The stone is in forms of a rhomboidal shape, and is cut by the waters into steps; it is in sheets, some being thin, some thicker.

THIS is very curious to be seen, and brings a great many observations to the naturalist. The top of this mountain seems to contain minerals, there being very few trees upon it, and a very poor vegetation; indeed there is none in many places. I found there the *myrica asplenii folio*, and *hypericum arborescen.*, very extraordinary shrubs for this place. On following this little path, we went in a large basin surrounded by mountains, cut strait, and terminated by different conical tops; three small vallies reunite there as in a cavern. I had, on seeing this situation, a thought, that there had been a *volcano*, but finding no complete proof, I waited till I should have seen the whole place. There is a good farm in the middle of that fine spot, &c. About the west-end of that place, having the shape of a *funnel*,

there is a little hill, in comparison with others close by; upon the west declivity of this hill there is a large place filled up with all sorts of stones, more or less worked by fire. The water comes out among all these stones, and leaves a whitish sediment all round. The smell, which is that of the *hepatic air*, may be perceived at the distance of half a mile. Very few birds attempt to cross over the springs: to them it is a new *avernus*. Vegetation is very indifferent upon the hill, but lower down it becomes better.

THESE springs form a pretty strong stream a small distance from the bath-house. The waters now leave no more sediment upon the stones; they retain very little of the hepatic taste, and about three miles off there is nothing of it. Then one may see more birds flying. In the declivity going to the spring, is a run made by the rain-water, which falls into the spring, sometimes spoils it, and brings in strange compounds. Upon the opposite side of the hill is the true basin of the whole spring, which would be a good deal bigger than the *warm springs*, if it was cleaned a little for the various uses of the people, and the benefit of the owner.

THE place has been entirely overturned by some great revolution, all kinds of materials of
old

old mountains are mixed with those of new ones; all cemented by fire. A great many stones which have evidently been worked by fire, are like *pumices*, very light, full of air-holes, and not so heavy as those which have undergone that *torrefaction*.

I BROUGHT specimens of each, to shew to any body curious in these subjects, which were viewed by several gentlemen there. From all this I infer, that the place I call the large basin, is an old *crater* of a *volcano*, filled up a long time since by the destruction of surrounding matters. The waters having washed away all earthy substances, there remained only stones and their fragments of different sizes, as may be seen upon the spot, where, on walking, one seems to tread upon old ashes, such as are round iron works. This creaking sound is never to be observed but where there are volcanic ashes, *pumices*, &c. as about the volcanos.

NOBODY will suppose that there were any iron works or any glass houses there. This observation, which is quite new for this country, is not the only very important one made upon the natural history of these mountains, and of the country.

I SAID above, that the large bottom, joined by three narrow vallies, was surrounded by the
mountains

mountains, cut strait, and divided by cones of various bigness. It is not improbable, that in this place there was the great *focus* of the whole, and that the hill where these waters spring, was the passage of *laves*, and of ashes, accumulated upon there. This gives a better explanation of the stones of the old mountain found there, where there is no limestone, and no kind of substances produced by recent revolutions, because those substances have been washed away. Notice may be taken of it on the whole hill, upon the stream close to a high *road*, where the Indians were used to come for paint. There I found a *yellow* and *red bolus*: close by there is a kind of black substance, which has been thought to be *coal*; but it resembles rather some kinds of *manganese*, or the *schistous-stone*, which lies at the top of pit-coals. I could not try any experiments upon it, but whatever it is, it gives a new strength to my discovery of the volcano. Some people have thought it was a *coal*, because of the appearance of the discovered iris between the sheets on breaking it; but this is not a sign peculiar to coal, it is not to be met with in any accumulations, which are of another kind. What is against this opinion, is this, that being exposed to fire it does not burn, but turns grey, and keeps its solidity, whereas coal would fall into ashes, more or less solid, and be very light.

THE hepatic water comes out through all these volcanic remains: a great number of bubbles come up at the surface, which received in a bladder, prove, by various experiments, to be hepatic air, mixed with a little of aerial acid. The fluid has an action upon the eyes, nose and breath, and occasions a head-ach, which soon goes off, if you stay there. Sometimes, in this water, and in *hepatic air*, vegetables grow very well, even in the spring: these plants belong, I believe, to the genus of *confervæ*, &c. There is also a light white sediment, mixed with sulphur, all along the little canal conducting water to the bath-house, which is very large, and convenient for the place. There is not such a quantity of sulphur as a great many persons believe; on the contrary there is very little, and the vegetables being covered by it, make it appear in greater quantity than there is in reality.

THE natural history of the place and the feat of this spring being known, it is now necessary, for public utility and the good of mankind, to make inquiries concerning the several substances contained in these waters, in order to enable us to distinguish one from another, and to judge of their medical properties, which more deserve our attention than those that have only philosophical curiosity for their object.

I USED the same way and processes for analysing this water, that I did in the others, some particular experiments excepted, which were necessary according to their sulphurous nature, &c.

THIS water is very cool in summer; it has no other taste but sulphurous. Some persons find a little acidulous taste: it is very clear and white: the smell goes off if it stands by for a little while; if however it is carried off in a bottle well corked, it retains a long time its vapour, which makes it more easy to be transported out of the place, to be used for different purposes, according to the people's desire.

EXPERIMENTS BY RE-AGENTS.

1. THE blue tincture of violets was a little changed to a green color, which soon went off; this seems to be owing to calcareous salts.
2. A SPIRITUOUS tincture of gall-nuts gave a very light purple color; which is a proof of a small quantity of iron.
3. FIXED vegetable alkali, produced a white precipitate.
4. A SOLUTION of silver turns it black; it is owing to the sulphurous vapour, or to a little of that substance contained in it.
5. A PIECE of silver put in the said water turns
black:

black: this is a full proof of the existence of sulphur and its vapours.

6. COMMON spirit of nitre, pretty strong, formed no precipitate; that is a sign of very little sulphur.
7. IT does not dissolve soap.

THESE are the principal experiments which I tried; all the others, which it would be too tedious to relate, are additional proofs of these, and help us in forming a conclusion respecting the contents.

THAT I might better discover what kind of earth and salts are contained in this water, I evaporated, in the same manner as before, eight quarts, and proceeded to a slow evaporation, in order to obtain the easier, some products apart; the result was as follows.

THE *hepatic air* obtained was not inflammable on account of the quantity of aerial acid mixed along with it. After this, some aerial acid left its combination with lime because of its attraction to the atmosphere. This earthy substance appears in a degree of heat before the water boils, and as soon as the air begins to escape, it falls to the bottom of the vessel, in the form of scales; sometimes it is alone, sometimes it is mixed with

II

a little

a little of selenites, when there is any in the waters. Aerated magnesia separates afterwards, either because it is in smaller proportion, or because the combination of air is more intimate. In the progress of evaporation to dryness the residuum seems to be rather earthy than saline; it has a smell of sulphur, and is black.

ON repeated lotions of it, the whole being filtered to have the salts dissolved in water, and evaporating all these lotions to a point of crystallisation, few days after there appeared different kinds of crystals, easy to distinguish with a magnifying glass. Every time I poured new distilled water to the residuum, it smelled of sulphur.

THE salts obtained by the evaporation of the lotions, were *vitriol of magnesia*, selenites, and a little of mineral alkali; the *mother water*, which was brown, upon being examined, was found to contain calcarious marine salt and iron. It appears from these experiments, and a good many others, too tedious to be related here,

THAT the *earthy* part remaining upon the filter, which was partly combined with hepatic air, partly with aerial acid, is of a calcarious nature. The quantity to the quart is 20 gr. which is a large quantity; but I shall immediately explain

in

in what manner this quantity is contained in the water. The other products are iron and a very little of sulphur.

It is probable that the two airs contained are the solvents of the calcareous earth of the waters, because it seems to agree pretty well with the property which some authors give to aerial acid of dissolving so much by inches. * As for the hepatic air, nobody has yet ascertained the quantity it may dissolve in earthy *hepar*. It is certain, however, that on precipitating it, the *hepatic air* on flowing out, carries away some of it, as it is to be observed at the spring, where having an elective attraction with the atmosphere, some earth settles upon the stones, as I tried there. As for the formation of hepatic air, whether it comes out of an *hepar*, or of a volatile *sulphurous acid*, whether altered by aerial acid and common air, the re-action then is occasioned, either by a calcareous substance, or the little quantity of *marine alkali* very common in these kind of springs. The water contains by the quart as follows, viz.

Of hepatic air,	-	-	-	
aerial acid,	-	-	-	
calcareous earth,	-	-	-	12 gr.
	H	2		Of

* See *Bergmann* on the aerial acid and lime.

Of vitriol of magnesia,	-	-	5 gr.
selenites,	-	-	2
calcarious marine salt,	-	-	$1\frac{1}{2}$
iron, more or less	-	-	1
fulphur precipitated,	-	-	$\frac{1}{4}$

THE hepatic air gives a strong impression to water, without yielding much sulphur. Hence I look upon the hepatic air contained in water to be accidental; it does not constitute exactly its nature, but the water coming through volcanic materials meets some hepar and a decomposition is operated: then the water charges itself so much with the hepatic air, but not always in the same quantity; because sometimes water is strongly impregnated, sometimes it is less, without altering the other contents, and affording another virtue in the use of it.

WHAT I say is confirmed by experience, and the treatment of different diseases, as, e. g. itch, &c. the cures of which ought to be perfect, but are not. Where real sulphurous waters are used, the cure is complete, the disease never appearing again, as it does upon many people having used of this water. It is very easy to see, after what I have said above, and from the contents of these waters, that their properties are uncertain; this is the reason why some use them as *aperitives*, and
the

the common *idea* is to believe them good for any cases where the others did not operate any thing upon the patients: as for this, it remains to know if other waters have been taken properly, and with the true application to the case.

FROM thence physicians will take care of stories often in contradiction with the nature of things. This difference of effects leads sometimes to a discovery of a morbid cause unknown before. We have now only to determine to what kind of disorders these waters may be applied.

ALL the cutaneous or *skin* diseases, as, common itch, all kinds of pimples, red spots, whether *scorbutic* or not, some *fistulas* or runnings, and cracks of the skin, without an internal vice of the humors, having only the skin for their seat without complication, may be relieved entirely, on drinking this water and bathing in it now and then the whole body, washing frequently in the day. The bath being very cold, it is necessary to take care not to be in a sweat or perspiration, because it would not succeed so well on account of the coldness of the water.

A QUART in the morning and one at night, eating no supper, is the true quantity to drink: some may drink three quarts, observing that it
must

must be at least three or four hours before or after any meal.

PERSONS afflicted with any external diseases, must be rubbed all over when they are bathing, and this frequently in the day with the water, in order to raise a better circulation all over the skin. This is a point quite necessary for receiving complete benefit of this water, and induce in the small vessels an oscillation lost for some time, and to take their primary functions in the system. A great part of these disorders is often nothing but a continual error of circulation, caused by a *plethora ad vasa*. All comes in order when the fluids acquire by remedies their natural fluidity, and the proportion to the shape of the vessels; without that, error follows and the fluid breaks out and occasions all kinds of sores, more or less difficult to cure, according to its nature, whether ferous, or lymphatic, or mixed.

ALL these are much more difficult in the female constitution, on account of the laxity of their vessels, and the tenacity of lymph. Those, on the contrary, of a ferous appearance are worst, because the serum corrodes the small vessels by the acrimony of the salts contained in the blood. This difference of fluid is the great cause of various ulcers, and these treated by acids, as
lemon-juice,

lemon-juice, vinegar, &c. may be cured sooner than by any ointments, as I have experienced for twenty years that I have practised the different branches of physic.

ALL kinds of the swelled glands, having a scorbutic origin, whether in suppuration or not, being well prepared before, may be relieved by *hepatic waters*; but in these cases there are some other remedies to be enjoined by physicians, and a proper diet suitable to the case: then such diseases may be completed by a crisis assisted by waters. There are some other kinds of diseases to be cured by hepatic waters, such are *nodes, callosities* in different parts of the body, which are troublesome, and painful at certain times. No other remedies will remove them but cold or warm hepatic waters.

In general, all kind of lymphatic diseases, from accumulation, except those of the venereal kind, may be attempted and cured by hepatic waters, or at least alleviated a great deal.

CHAPTER IV.

Of the Warm-Springs, or Thermals

BESIDES the cool mineral waters of different qualities, as I have explained before, nature, always wise, has formed some other kinds, of a different composition and temperature, and they are endowed with virtues, which contribute more or less in the cure of the different diseases in which they may be advised: they begin cures which the cool waters alone can complete. From the unequal distribution of the nervous fluid arises a slow circulation, or none, in some of the remotest parts: by the help of *thermals*, disorders from this cause, may be sooner relieved than by any other means. Irregular motions of the *muscles* fall under the same observation.

ALL the waters exciting a hot sensation were called *thermals*, after the latin name *thermæ*: as this is generally a known name, I shall retain it here, with regard to the two springs of which I have yet to speak. The first is less hot or warm. This wonderful spring is situated pretty nearly in the middle of the *new mountains*, at the bottom of one tract of the chain called *warm spring mountain*, in Bath county, one of the highest ridges after the blue ridge: but respecting its
height,

height, I shall say nothing, having had no barometer with me to measure it, &c.

ALL the sides of the mountain are mostly composed of freestone, lamellated in all kind of ways, but in general inclined to the horizon. This freestone seemed in some places to have been warmed by fire, and some parcels which have been spread about for a long time, are *soporiferous* upon being touched with iron. Sometimes a white *quartzous vein* crosses it. On the one side there is a *schistus rufus lamellatus mollis*, which being washed away by rain, after it has been broken by injuries of the air, forms the *humus arabilis*, or ground of the vallies, where there is any husbandry established. Under this bed is a blue marble inclined to the horizon; this is crossed by a white vein of crystallized aerial *mephites*, or common calcarious spar. This marble is very good for lime, and could be worked with advantage for any other uses. About sixty yards from this place, is this famous spring, contained in a large basin built in stone, of which the diameter may be twenty-four feet, and of an octogon shape: the place is not covered, there is only a wall to keep the *bathers* out of sight.

THE situation of this bath is one of the most agreeable in these mountains, and it is more easy

to find in its neighbourhood, necessary provisions for to be well accommodated. The air is very good there. It would require but little repair to render it one of the most agreeable spots for spending the whole summer; but improvements can not so soon take place. The bath might be divided, so as to have cool water when necessary, and each patient might have his room and a bath close by, which would particularly suit the convenience of rheumatic persons. The water coming out is in such plenty as to be able to turn mills if they were established upon it, about half a mile off.

HOWEVER blue the waters may look, it is nevertheless as white as all the others: that blue colour proceeds from the fragments of blue marble at the bottom, and the reflection of the sky.

THE taste of the water is something acidulous and *fætid* or *hepatic*. The elastic fluid escaping through the water in bubbles, is no other air but the *hepatic*: it makes some impression upon the nose, eyes and breath, occasioning a small *head-ach* which soon goes off, and still quicker, on moving out of the column of it. This hepatic air is very volatile, and evaporates when exposed in an open vessel, before it can be brought to the house, when all the taste is gone, the water being

ing still warm. This is a proof of the incomplete combination between the air and water: however, all its properties depend upon the quantity of air contained, which induces persons to go to the spring and drink there.

THIS water being mostly recommended as preparatory to the use of the others, the bath is the principal object to be considered. I took notice of it myself, and likewise other persons there, that the water was rather relaxing to the *stomach*, therefore in a *plethoric* constitution it causes a loss of fluid by sweat and by bath: care therefore, is to be taken of these matters, upon using of it. This first effect being once over, then it operates as a salutary and very agreeable bath. The question now is whether this water owes its properties to *hepatic air*, or *aerial acid*, both being contained in it. As I think there is more *hepatic air*, its properties are rather to be attributed to the latter.

EXPERIMENTS BY RE-AGENTS.

1. THE water drunk at the spring has a strong hepatic taste and smell.
2. THERE is no alteration of a blue tincture after eight and forty hours.
3. IT makes no kind of effervescence.

4. PHLOGISTICATED alkali produces no alteration on it.
5. FIXED alkali precipitates a little of a white powder.
6. MINERAL alkali does the same.
7. A SOLUTION of mercury disengages only some air bubbles.
8. A SOLUTION of silver turns it a little of a pale hue, and throws out a good many air bubbles.
9. IT does not dissolve soap.
10. LIME-WATER occasions a small white precipitate.

THESE are the principal among all the different experiments I tried upon this water by reagents. I shall now proceed farther by evaporation, and compare both ways in order to discover the true nature of this very difficult water.

I FIRST evaporated three quarts, but finding hardly any *residuum* or pellicle, I added to it ten quarts, to evaporate, as before, in *balneum mariæ*. In the progress of evaporation some air bubbles came up sticking to the vessel. A piece of silver left in it a long time was not altered at all, which is a sign that it contained very little or no sulphur. The evaporation being reduced

to

to a quart, became clouded, and then a little of sediment began to separate, which being collected and examined, was found to be nothing but calcarious earth, which had been before dissolved by aerial acid. There are hardly two grains of this earth to the quart, which is a proof of the small quantity contained in it before the evaporation. On continuing the evaporation to dryness, and then dissolving the residuum by different lotions in distilled water, and evaporating it again, I found a little of *marine calcarious salt*; hence it follows, that the warm spring water is one of the lightest known; it is almost as pure as distilled water mixed with some hepatic air. It contains to the quart:

Of hepatic air	-	-	-	
aerial acid	-	-	-	
calcarious earth	-	-	-	2 gr.
felenites	-	-	-	$\frac{1}{2}$
calcarious marine salt	-	-	-	1

THESE are all the contents which I observed, I could not determine the exact quantity of air, but leave this matter to the care of some future philosopher, who will visit the spring with a proper apparatus, to ascertain this point, according to some new experiments lately made in Europe.

WHAT-

WHATEVER sulphureous taste this water may have, it is not possible to find any sulphur in it: whether it is all dissolved by hepatic air, or flies off; at least it is certain that there is no sediment of it, as is the case with respect to the water at *Aix-la-Chapelle*, where there is none to be found. When there is a sediment of it, *Bergmann* found out the best process to discover it; but this process would not succeed upon the thermal hepatic water of this kind. The quantity of hepatic air, is in a small proportion, and as it is very volatile, nothing can retain it to enable us to estimate the quantity of the sulphur contained in it.

ALL these taken together, make it one of the lightest waters hitherto known. *Plombières* water in Lorraine, in France, is very light, but it contains more selenites, &c. than our *thermal water*. On following the meadow, in the middle of it, there is another small spring as warm as the other, which has not been opened: its water falls into the stream of the other spring. I believe this water is better for internal uses than the great spring: it appears, that some iron, dissolved by aerial acid, is contained in it. The hepatic air is not so strong, and, in general, there are more contents in it.

ALL

ALL the right side of this hill contains warm waters, whilst the left side contains none at all; the bottom of the run is covered by calcarious mephitics, which is sometimes crystallized, and sometimes in rocks or masses. The great spring, as I have already said, is situated upon a blue marble which decays slowly, and the water destroys the calcarious earth to such a degree, that there is no solidity in the wall. I believe it would not be easy to make any solid building on the spring, on account of the great number of crevices formed by the water in the rock, as it is in all other springs.

ALL these vallies are composed of the same materials. The waters, in succession of time, have left their sediment under irregular forms, with intervals; new waters coming over, have either filled them, or washed some away, in such a manner, as to make them fall, or have formed holes on dropping upon a soft sediment. All these things are to be seen upon the place; hence that variety of caves, almost all formed in calcarious stone, and where there are, or have been, such caves, the water has generated air; and assisted by aerial acid, has dissolved all the substance to carry it a little way off, and there left it, on account of different attractive bodies,
such

such as the atmosphere, salts, &c. which it met on running down.

A GREAT peculiarity in these mountains, is this, that we find, between two ridges of *old freestone, cos antiquus*, materials of a more recent revolution, which has brought there calcarious blue earth, and it is upon this basis that we discover all the mineral waters. Is this accumulation owing to a revolution, which took place before the other, or was it left there by the sea?

ON going down about two miles, and following the stream, which cuts its way through the rock, we observe the blue stone covered by the sediment of water. All this is formed by a felenites, and the calcarious mephites, or calcarious spar. Good, cool, fresh water is frequently to be found close to the warm water; because it comes from a higher place: the one issuing out of the rock is cool, the other springs out of the bottom. It is possible, however, that they may have a communication in some place. The cold one takes hepatic air on falling upon the place of decomposition, and impregnates itself; the remaining air comes up along with it, and appears under bubbles, because the water can not dissolve it all. This strength of expansion is greater on account of the heat and attraction
with

with the water and common air. In the sweet springs putrid fermentation is the principal agent, as a good many experiments, which it would be tedious to relate here, will explain in time, the subject belonging to the natural history of mountains in general.

HAVING sufficiently spoken of the warm spring, it now remains to give some information about its medical properties. *Hepatic air* is the most active of its products: that alone has a real effect upon the animal œconomy. The heat is another agent we must pay attention to, when patients wish to use the water of which I am speaking. As for the salts and earth contained in it, I look upon them as being of very little effect. Their quantity being so small is not sufficient to prevent the relaxation which the bath often induces.

It may be ordered by physicians as an aperitive in all kind of rheumatic pains, palsy, rigidity of the muscular fibre, as well as in suppressed perspiration, *catching of cold* upon the place, &c. This water may likewise be employed with advantage in particular cases. The hepatic air in the warm bath will greatly assist the cure of cutaneous diseases, as, itch, leprosy, elephantiasis, all the scorbutic eruptions, old ulcers, swelled glands, irregular pains after old rheumatism, &c.

In these cases it ought to be advised by all the learned physicians of this country.

I do not speak of this water as being able to operate complete and quick cures; but as a good preparative to be employed before using any of the others, which by their materials may better accomplish a cure to the satisfaction of the patient. Any body who wishes to try of this water must use it with care, in order to avoid the relaxation which would keep him weak, and hinder the good effect of this, and of the others, to be taken for this purpose.

To drink this water it is better to put it in a bottle at the spring and cork it well; let it cool, then drink it, or else it is liable to relax the stomach. When this precaution is taken, it produces no such effect, weak stomachs will digest it easy, especially if it was possible to add some aerial acid; then it would be very easy to give it all the properties of other waters. Every thing in this renders it capable of receiving any new mixture: but it is not necessary to attempt it, the others being at hand for any purpose we may desire.

CHAPTER V.

Of the Thermal water which is hotter than the preceding.

ABOUT six miles from the preceding spring, on following the road between the two high ridges, we come to the end of a valley, where the water, or brook, has cut its way through the *petro-flex*, down to Jackson's river. This bottom is covered by the various materials of the destroyed mountains on each side, and offers all kinds of stones, as, freestone of different colors, the red kind especially, which is sonorous. There is plenty of the blue marble crossed by a white vein of *calcarious mephites*: all the surrounding substances are bottoms of old cavities filled up by fragments of all kind of materials. The uppermost of the mountain is cut in different cones all round, which are mostly *sterile*, or at least vegetation is very poor all round about them, and in general there is little of water in proportion to the mountains.

THE springs are upon a *hillock*, and come out among mud and grasses of different kinds; some holes have been cut in the calcarious sediment upon the declivity, to make a kind of bath. The water springs through these sediments, and is of

a middle temperature, between half boiling and warm water, so as to support that heat very well on bathing in it. Whatever may be the heat of this water, it does not prove unfavorable to vegetation: there are plants growing in this water, and all the kinds of plants natural to springs in general live as well in this as in a cool water. This may be attributed to the aerial acid, which probably keeps them from being overheated, because these waters contain more of this acid than they can retain in combination.

THERE are in the composition of the place adjacent to these waters all kinds of substances; but the chief of them is always of a calcarious nature, colored with iron, brought and accumulated there by the waters a long time ago. It seems that there is here a continual decomposition and reaction of one substance upon another. It is highly probable that *pyrites* or *mundics*, contained under ground, are the cause (by their deflagration) of the heat and new composition of *aerated* water. Calcarious earth joining to the vitriolic acid of pyrites raise a heat, and then the aerial acid, disengaged from its combination, breaks up in the water, carrying along with it some part of the iron left. This is the reason why the iron is to be observed at the spring, settling upon the stones, when a little of it remains yet in water.

THIS

THIS place (of all the different springs that I have seen in Europe and in America) affords one of the greatest proofs of the opinion of philosophers concerning the cause of heat in some springs; but not of every one, as I took notice of in this travel. Here, however, there is no better account to be given, and none more probable; because there is plenty of pyrites: all the place is composed of a calcarious mephites, the water out of that place and close to this ground is cool, and contains the other principles, except that it is not hot.

HENCE, and from a good many other experiments, I conclude that the *Hot springs* owe their *thermal* and *aerial* properties to a decomposition of a pyrites, by the calcarious earth, and the vitriolic acid reacting upon each other; it thus produces aerial acid, which flying up, carries some iron along with it, and makes this water a *chalybeated* thermal water.

ALL the spongy sediments around the spring, about half a mile, on following the stream, are of the same nature. The water detains its heat as long as there is any substance of the same composition, till it is mixed with other waters. These sediments are so much penetrated by the waters, that on walking upon them, there is a *crepitus*

or

or noise, under the feet, and on breaking ground we see water underneath. Any *vegetable* substance falling in, is soon covered by a light incrustation, and retains its shape very accurately, and this incrustation is effected in a short time.

THE reader who is well acquainted with the theory of the different kinds of air, will easily perceive that there is a combination to form a new water. These springs coming out of the calcareous sediment, dissolve and settle what they took before upon the place, and there is only lost the fluid, which escaping, is regenerated in proportion. This is the nature of *thermal aer'd* water, which is very different from the preceding in its degree of heat, in the *acrial acid* which it contains, and in there being no *hepatic air*, &c.

HENCE, their medical properties are very different, the one being a palliatif and the other a curatif if it is properly used. This I shall prove farther by analysis, and thus enable physicians to take this difference into consideration.

EXPERIMENTS BY RE-AGENTS.

THE water has no particular taste, neither *acid*, *hepatic* or *astringent*. It is very clear, a great

great quantity of air bubbles comes through it to the surface, which being gathered, proves to be a *superfluous aerial acid*.

1. GALL-TINCTURE poured in the water alters it but very little, but leaves an *iris pellicle* at the top: this is a proof of a very small quantity of iron, the greatest part settling in the spring as soon as there is a communication with the atmosphere.
2. A BLUE-TINCTURE was not altered at all; this proves that the water has no *superfluous aerial acid*, as would have been thought by the taste of it.
3. FIXED alkali produces a white sediment of a calcarious nature.
4. A SOLUTION of mercury forms a yellow precipitate, which was much more evident when I poured it in the spring itself; all the water was then turned yellow.
5. A SOLUTION of silver turned the water white.
6. It does not dissolve soap.
7. LIME-WATER is precipitated by it.

ALL the different small springs upon the spot give the same products: it is not therefore necessary to believe that they are different, except in the sensation of the heat, according to the difference of the constitution, and irritability of the skin.

THE

THE more central the springs are, the greater is the heat, which is most owing to their being nearer the focus of the accumulated bed of reaction; however, this heat is always supportable, and never causes any irritation of the skin, and it may be supported by any patients without the inconvenience of a steam, as in the *warm bath* and *hepatic cool bath*.

THE only thing necessary here, are good accommodations, both for the patients a-part, and for such people who go there only for amusement and for company in summer. This spring might be improved a great deal, and with advantage to the owner; because it is a fine place, and it is but a small journey from it to the *Sparw-springs*.

ALL the experiments related above, would be sufficient enough to prove the principles of this water, and to convince us of its properties; but there remain some others to be discovered yet, upon which it depends as much, such as salts which must be contained in it; and to determine of what kind they are I shall proceed, before, by evaporation.

I EVAPORATED ten quarts of this water. A good deal of aerial acid came up swimming at the
the

the surface; then followed a white pellicle covering the whole, which soon falls to the bottom, till there is no more dissolved by the *aerial acid*. Being evaporated to dryness, the *residuum* was impregnated with a pretty strong sulphurous smell, which, I believe is owing to that reaction upon pyrites. This smell is very often perceived in places where iron is moistened, or in stagnating waters, and is attended with an iris pellicle, improperly called *oily*.

THIS water seems to contain about eight grains of an earthy substance to the quart, and about five grains of different salts, which is a very proper quantity to make a good mineral water for drinking cold. Hence it is not surprising that it operates so well, in different disorders, used as a bath. In both cases it is able to give great relief to patients. From all the experiments it was found to contain as follows, viz.

Of aerial acid	-	-	
lime aerated	-	-	8 gr.
vitriol of magnesia	-	.	2
felenites	-	-	1
calcareous marine salt			2
iron	-	-	$\frac{1}{7}$ and less.
	L		ACCORD-

THESE are the true proportions I found by repeated trials, whatever may be their variation from accidental causes; but their virtues not being thereby affected, they may be very properly applied to in different diseases, according to the advice of physicians.

HEAT and aerial acid are the principal agents in this water for external application: for internal uses the other contents are sufficient to have a very great effect, even in a short time, as diluents, and aperitives; and being kept well corked to cool, it operates as a tonic. However, discordant it may seem to be, we shall find the opposite properties when the water is cooled.

HENCE it may be good in all pains of the rheumatic kind, in palsy, atony of any part whatever, &c. I observed a very great glandular swelling cured in a short time, by bathing in, and drinking of it. The bath is very good to bring out again any humors which have been cured by repellents, as in disorders of the skin, in which it is very beneficial. All kinds of *tophus*, or *hardness*, may be cured by bathing a long time, also expansion of the milk causing all kind of *tumors*, whether running or not, will certainly be healed, if the patients be well governed.

verned. A great many other accidents of the lymphatic system may be cured in the same way.

DISEASES which are occasioned by *local plethora*, may be removed by bathing, and lastly venereal pains, frequently called rheumatism, stiffness in joints, &c. will be a great deal alleviated, and the whole cure could be effected, on joining other remedies suitable to the case.

THESE few remarks are sufficient to give a general idea of the several properties of these waters, to any physician, a little acquainted with his business, and any reader may very easily understand the explanation I have given. As for regimen, and diet, they must be directed according to the case and circumstances, and they can not be determined but on seeing the patient upon the spot; I therefore thought it useless to give any table of them, and what I began on the subject, is not yet complete enough to appear in public: this requires some more observations and inquiries, respecting each disorder in particular, and the application of the different springs, which I intend to treat of for the good of mankind, if I find sufficient encouragement for it from the public.

C O N C L U S I O N.

FROM all the experiments and researches related in this treatise on the *mineral waters* of Virginia, I am led to conclude, that these are endowed with more powerful properties than any that I have analysed formerly when I travelled and lived in Europe.

THE mineral waters, such as, *Spaw, Seltzer, Pyrmont*, in *Germany*; *Plombieres, Bourbonne, Bagnieres, Bareges*, in *France*; the first of which are acidulous, the second hepatics or sulphurous, have some properties common to ours, but not to the same degree and certainty. A good many of them have not yet had their properties ascertained; their analysis being not correct, and there not being experiments sufficient to enable physicians to advise one water in preference to another,

AND even in Paris, physicians of *high* reputation are rather governed by public opinion, from the patients desire, than by the certainty of analysis, and by experiments made after a solid method equally good for society.

BEING perfectly acquainted with all this insufficiency, I have attempted in this treatise to lay
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the whole of my inquiries upon a solid basis, that of *observation* and *experiments*.

IN writing this treatise I have endeavoured to express myself in a plain style, that I might be understood by every body, whether learned or not. Thus opinions, not having a sufficient foundation, it is to be hoped, will exist no longer, and truth, resulting from all these inquiries, be established in their place.

GENERAL directions for using waters, being not sufficient for every body, I thought that particular explanations or descriptions and comparisons would be much more easy to be understood by any person wanting to use these waters, especially for those, who are not acquainted with physicians, or who live far from them.

I THEREFORE collected all the properties of the *different waters* existing upon the spot in the same valley, and upon the same bottom, under the name of *acidulous*, that nobody might think that one or another was endowed with a different virtue than the *principal spring*; the difference which might be between them, residing only in the quantity of *inflammable* and *aerial acid*. This I observed in making experiments upon *butter-milk spring*, and some others all round these
places,

places. It is of no consequence to patients which of these waters they use: they will answer the same purpose in the different cases in which they may be applied.

WHAT I have said in this treatise, I have proved to be true by the natural history of the place, and accordingly it was impossible to be otherwise; hence I found out that there was only a difference between the *acidulous* and *spaw*; this last having all round it acidulous water, as good as that of the other place, and this having no *spaw*, makes a great difference upon the whole, the greatest part of patients wanting more to use *spaw*, either alone or mixed, &c.

I CAME, next, to an examination of the *sulphureous*, or *cold hepatic* waters, it being proper to use them after the preceding ones, in a good many cases, already explained.

FROM their principles I concluded, that they ought to follow according to the great cool temperature they have in summer, which, assisted by their other contents, renders them very great tonics, in a great many disorders, giving at once to the whole vascular system an oscillation necessary to a good circulation of the fluids.

Ex-

EXPERIMENTS had confirmed my observation, before I had finished *my analysis*. I found that a preliminary use of the *acidulous* or *spaw* water was necessary, in order to prepare the body to receive the benefit of the others, or else it would fail in many cases, as I had opportunity of observing it there, in different cases, where atony was a principal cause of the complaint; then a sudden impression and action of cold and hepatic air, help the cure much quicker than it would have been operated before. I thought it better to speak after of *thermals*; which are the second class of waters. There is a great difference between them, in the degree of heat, and in the variety of their principles; one being hepatic, affords very few contents, and is one of the *lightest* waters in the world. The other, which is much more efficacious, contains aerial acid; this makes a great difference in their composition and virtues. The properties of the hepatic thermal, are such, as to be an excellent preparative in any kind of cures, where relaxation is necessary. I explained the reason of it in its place, and this observation is very necessary, because those already in that habit of body must avoid their use, for fear of a greater relaxation and vice versa: then there will be more satisfaction for the patient, &c.

BUT

BUT those of a full complexion of body having other kinds of diseases, may use them without being much afraid of this, at least for a week.

THESE few remarks sufficiently show, how any one may come to a restoration of health by using these waters, especially when there is no error committed in diet, &c. necessary conditions, when we are desirous of our own conservation, or to keep ourselves in health, which is so precious to our existence.

THE great number of experiments which I made, and the observations of several kinds necessary upon these matters, engaged me to publish this treatise, for the welfare of society. There is nothing in it without having experiments and observations for its basis; the errors I may have committed were not in my power to avoid: I attempted to be useful to my fellow-citizens, and to mankind in general.

F I N I S

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